

disappeared through association at the comparatively low temperature of the stars.

Fig. 27 gives us a representation of the three chief types of stellar spectra.

It is thus manifest that in stars where the temperature is very high and the dissociation very great we have fewest lines, or at least fewest lines of that prominence and thickness which entitle us to associate them with substances existing below the surface of the stellar atmosphere. Here let us pause for a moment and reflect what this implies. If each element were in reality a simple body, and if the splitting up which occurs in the spectrum of each were merely molecular and not atomic, the result of a high temperature in a mass of matter containing presumably all the elements would certainly not diminish the number of the spectral lines indefinitely. For, even suppose that it split up all the molecular structures of each element into their simplest forms, yet on the supposition that they are elements, the ultimate molecular structure for one element would be different from that for another, and there would thus be at least as many molecular structures and spectral lines as there are elements. On the other hand, if these substances are not elements, we may imagine them to be split up into a comparatively small number of ultimate structures, and we might even imagine that at an enormously high temperature everything might be reduced to a single structure.

Thus the fact that in the hottest stars we have the fewest atomic structures is in favour of the hypothesis that the elements are not really simple bodies but compounds, it may be, of some primordial atom.

Let us now sum up the evidence derived from terrestrial and celestial sources in favour of this hypothesis.

*First.* There is experimental evidence of various kinds tending to show that the so-called elements are not essentially different from other bodies.

*Secondly.* In the terrestrial spectrum of pure metals at a high temperature certain lines are obtained for some one element that are extremely near, if not coincident, in spectral position with those obtained for some other element or elements. These have been called "basic lines."

*Thirdly.* We know that in the sun's atmosphere there is a process at work tending to separate the various molecular and atomic structures, and we find that the greater number of the lines given out from the sun's hotter regions are basic lines, such as we have above defined.

*Fourthly.* In the very hottest stars, where the dissociation is greatest, we have only a few prominent lines given out, these being lines belonging to hydrogen, calcium, and magnesium. I think we must conclude that the hypothesis that the elements are in reality compound bodies offers, with our present knowledge, a very good and simple explanation of the results of spectroscopic analysis in the earth, the sun, and the stars.

Now, bearing in mind the extreme usefulness of some such hypothesis to aid us in collecting facts, I do not hesitate to say that this hypothesis can only be legitimately overthrown in one of two ways. We may either, in the first place, obtain some indisputable fact bearing conclusively against the hypothesis that the elements are compounds and in favour of their being essentially simple bodies, and may thus overthrow the above hypothesis in the same way that Fizeau, by his experiment, overthrew the corpuscular theory of light, if, indeed, it had not fallen to pieces before he made the experiment; or, on the other hand, the hypothesis that the elements are essentially simple bodies may be applied by some skilled advocate to our terrestrial and celestial spectroscopic observations and a consistent explanation of these afforded, simpler and better than that given by the above-mentioned hypothesis. But until either of these two things is done we are justified in using the compound nature of the elements as a working hypothesis.

It would, no doubt, be premature to bring it forward at the present moment as an established theory, because an established theory means a working hypothesis which, having overcome the perils of infancy and youth, lives to justify an honourable and useful existence on the principle of the survival of the fittest.

BALFOUR STEWART

## NOTES

THE Paris Academy of Sciences has suffered another loss in the death of M. Jamin, Perpetual Secretary for the Section of Physical Science, and the immediate successor of M. Dumas. M. Jamin can hardly be said to have filled his office, as he was attacked by disease of the heart very soon after his nomination. He was elected a member of the Academy in 1858 to fill the place vacated by the death of Pouillet. He was a very eloquent teacher and debater, and a frequent contributor to the *Revue des deux Mondes*. His "Cours de Physique à l'École Polytechnique," is a very extensive work. He also published many papers in the *Transactions* of the Academy of Sciences, and patented an electric light. He was born in 1813, and educated at l'École Normale.

THE death of Mr. Edward Thomas, one of the most eminent of English numismatists, took place on the 10th inst. at Kensington, in his seventy-third year. After a distinguished career in the public service in India, he returned home and devoted himself to the study of the antiquities and history of India and Asia generally. He was a Corresponding Member of the French Institute and of the St. Petersburg Academy, as well as a Fellow of the Royal Society. His writings were very numerous, and many of them are still only to be found scattered throughout the journals of different learned Societies, to which he had contributed for upwards of forty years. Amongst his most important works were his edition of Prinsep's "Antiquities," published in 1858; papers on ancient Indian minerals in the *Journal Asiatique*; on early Sassanian inscriptions, seals, and coins; his essay on ancient Indian weights prefixed to the "Numismata Orientalia" is the standard work on the subject. Between 1848 and 1865 he contributed sixteen papers to the *Journal* of the Royal Asiatic Society on Eastern coins. These were subsequently republished under the title of "Tracts on Oriental Literature."

THE death is announced of Dr. Heinrich Fischer, the mineralogist and professor at the Freiburg University, well known through his work on "Jadite and Nephrite."

IN a lively and interesting article in Tuesday's *Times* on the work of the Smithsonian Institution in the field of ethnology it is urged with some force that the British Government is bound to render a similar service to science in the case of the numerous races under our dominion, many of whom are dying out, or changing their old habits and customs. "All the arguments which could be urged for the maintenance of the Smithsonian Bureau of Ethnology apply to the establishment of a similar bureau for the British Empire. In British India the State from time to time undertakes fragments of the task. Elsewhere it is being effected occasionally and piecemeal. The want is of a body which should carry on the enterprise as a whole, and in a manner to borrow light from one quarter to elucidate the rest. Types of tribal, social, and national existence are vanishing on every side. They are changing, or giving place to new. Some had always the germs of incurable decay in them. British civilisation is treading out others. British dominion, whether directly answerable or not for the mortality, is in the position of administrator, and is bound to keep account of the estate of ancient and curious memories. Being where and what it is, it ought to be executing on a scale yet ampler the work the Smithsonian Institution is doing diligently from and at Washington."

This really forms a part of the much wider question of the duty of the State to science; though with our officials spread everywhere over our world-wide possessions, it ought to be an easy matter to collect abundance of data with which the ethnologist could deal.

M. GRANET, the French Minister of Posts and Telegraphs, is connecting telephonically Paris and Brussels. When the connection has been completed he will also connect Lille and Paris.

It is satisfactory to learn that success has attended the attempts lately made by the eminent Norwegian naturalist, Herr Bock, and his coadjutor, Herr Schwabe-Hanssen, to introduce a new form of industry into their native land, by utilising some of its numerous beautiful native minerals for the fabrication of various objects of art. For this purpose they have made use of the light-green so-called "precious" serpentine, which, although generally scarce, occurs in abundance at Modum, where ophite and magnetite are also found in sufficient quantities to warrant the hope that the supply will repay the necessary cost of raising and working these decorative minerals. Equally valuable for ornamental purposes are the iridescent, or Labrador, feldspar of Fredriksværn, the aventurine of Tvedestrand, and the tulite of Leksvik, near Trondhjem, but hitherto these minerals have not been found in sufficient quantities to admit of including them among the genuine Norwegian materials of decorative industry.

HERR WERENSKJOLD reports in *Naturen* that on January 5, at 5.20 p.m., he noticed a so-called fire-ball, which was observed in the district of Aas to be moving in a south-westerly direction near Orion's Belt, till it disappeared behind a bank of clouds in the neighbourhood of  $\beta$  Ceti. Its motion was undulatory and slow, and in size and brightness it resembled Venus on an ordinarily clear evening, while it was surrounded by a luminous circle, whose diameter seemed to the observer to be about 2 metres. It continued visible for fully 20 seconds.

IN an interesting paper on the Bushmen and their language, by Mr. Bertin, published in the last number (vol. xviii. part 1) of the *Journal* of the Royal Asiatic Society, the writer discusses the ethnological position of this people. He agrees with Dr. Fritsch in thinking that they have none of the characteristics which would warrant either of the suppositions that they are the result of a mixture of all the runaway slaves, or that they are the broken remnants of a degraded and decayed population. They can only be said to have decayed when they have accepted a certain measure of civilisation. The area formerly covered by them was much larger, and extended over regions now exclusively occupied by Hottentots and Bantu; but there is no means of knowing how far they extended into the interior, although there is some reason to suppose that at one time they occupied the central part of the African continent. Anthropologically, the Bushmen, Mr. Bertin states, offer all the characteristics of the Negritos, especially of those of the Andaman Islands. The similarity is not confined to the skull, as noticed by Prof. Flower, but extends to the colour of the skin, formation and tint of the hair, absence of hair on the body, proportion of the limbs, smallness of the extremities, and reduced size of the stature. The central part of Africa is not yet sufficiently known to enable us to say with certainty whether the Bushmen may be connected with any other African population; but there was, the writer says, a race, now nearly extinct or obliterated, which shows many of the same characteristics, namely, the Egyptian race of the first dynasties. He thinks it safe to say that both populations came from the same primitive stock, and have been modified by crossing with other races, and many other causes. This stock was a kind of Negritoid race; the ancestors of the

Bushmen were thrown on the Hottentot population, whether or not this was indigenous or extraneous—in their tales the Bushmen always speak of a previous population inhabiting the country—and it is no doubt the inevitable infusion of Hottentot blood which has given them the few characteristics they have in common.

HERR L. RUTENBERG, of Bremen, the father of the well-known traveller recently murdered in Madagascar, has presented the Bremen Natural History Society with the sum of 2500*l.* for a Rutenberg Fund in commemoration of the services his son rendered to science.

Two moderately violent shocks of earthquake are reported to have occurred in Rockland County, N.Y., on January 16 about midnight. They were noticed in various localities, such as Haverstraw, Rockland Lake, Spring Valley, Piermont, Sparkill, Nyack, and Suffern; no damage was done.

AN East Greenland Exhibition at Copenhagen, consisting principally of ethnographical objects brought home by the Danish East Greenland Expedition under Lieut. Holm, is attracting much attention in the Danish capital.

THE proprietors of the Ostrau Karwin mines in Silesia have offered, through the Minister of Agriculture, a prize of 1000 ducats to any one who shall discover a method for extracting coal from pits without occasioning accidents by explosions of fire-damp or combustion of coal-dust.

THE will of the late Prof. Henri Milne-Edwards, F.R.S., has been proved in England, the personalty in this country being over 8000*l.*

THE temperature of German Alpine lakes has been recently studied by Herr Geistbeck. It is shown, *inter alia*, that some lakes have a much wider annual variation of temperature than others. Small depth and large affluent streams are causes of a higher temperature in summer and a lower in winter. The cooling in autumn, it is noted, goes on much more rapidly than the heating in spring; for in autumn the upper layers of water, getting heavier through cooling, sink and give place to others, causing a strong and continuous vertical circulation till the whole mass reaches the temperature of greatest density; but in spring this circulation fails. Large affluents, too, by promoting mixture, cause rapid heating. Herr Geistbeck distinguishes three or four zones in these lakes in midsummer. Down to about 6 to 8 metres the fall of temperature is very slight, only a few tenths of a degree. Then, to about 18 metres, there is a rapid fall, from about 14°–20° C. to 8°. The fall continues to about 50 metres, but is now very slow (3½° to 4°). Below 50 metres the temperature is about constant and 4.2°–4.5°. The daily variation disappears within the highest zone.

FROM a simple experiment with a small ballistic pendulum (*Wied. Ann.* 36), Prof. Mach estimates the velocity of the wave of explosion of 0.02 gr. fulminating silver to be about 1750 metres (say 5833 feet) per second, and so, very much greater than that of ordinary projectiles. Thus is readily explained how a little of the substance exploded electrically on a glass or metal plate, or a card, fixed in a free position, makes a hole through it. The resistance of the air would appear to have nothing to do with it, for explosion *in vacuo* penetrated a card quite similarly, though with less noise. The gases of explosion acquire, in an immeasurably short time, and with nearly the same density as the solid body, the whole high velocity imparted by the work of explosion. As this is of the order of projectile-velocities, the plate is shot through, the lower half of the exploding mass acting against the upper, and the two acquiring equal and opposite velocities. With paper or tinfoil on a table, explosion produced (by reaction, no doubt) an upward convexity, sometimes with rupture.



It is the intention of the authorities at the South Kensington Aquarium to endeavour to introduce herrings into the collection of fish now on view there. The difficulty of naturalising this species to artificial existence is very great, as has been proved by former experiments. At sea-port aquaria, however, where a continuity of salt water may be obtained, this difficulty is obviated to a great extent, but at inland aquaria, where the water is seldom changed, it necessitates extraordinary skill to keep them alive.

At a meeting of the Council of the National Fish Culture Association, held last week, it was stated that the American Government had forwarded another consignment of Salmonidæ ova since the previous week, and the hatchery was now replete with eggs. It was further stated that the hatchery had been reconstructed and enlarged to meet the strain placed upon its accommodative capacity, so that the Association was in a position to incubate any number of ova.

A LARGE supply of salmon and trout ova has been despatched to New Zealand by Sir Francis Dillon Bell, who is most desirous of stocking the waters of that country with Salmonidæ. The ova were obtained by the Tay District Fishery Board, and deposited in the Howietown establishment until ready for shipment. Much is being done to advance the New Zealand fisheries, and the attempts made in this direction have terminated successfully in nearly every instance.

THE additions to the Zoological Society's Gardens during the past week include a Pennant's Broadtail (*Platycercus pennanti*) from New South Wales, presented by Mr. H. Stacy Marks, R.A., F.Z.S.; five Adorned Ceratophrys (*Ceratophrys ornata*) from Buenos Ayres, presented by Dr. F. C. Strutt; a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Mr. Charles Kershaw; a Common Gull (*Larus canus*), a Black-headed Gull (*Larus ridibundus*), a Kittawake (*Rissa tridactyla*), British, purchased.

### OUR ASTRONOMICAL COLUMN

NAVAL OBSERVATORY, WASHINGTON.—The following novelties occur in the programme of work to be pursued during the year 1886 at the Naval Observatory, Washington, recently published:—

"With the great equatorial it is proposed to make observations of some of the fainter stars in the Pleiades to connect them with the bright ones recently measured with the Yale College heliometer. With the 9·6-inch equatorial observations of variable stars will be commenced. A photometer for this instrument has been ordered from Alvan Clark and Sons; a spectroscope by Hilger is ready for attachment."

THE SECULAR NUTATION OF THE EARTH'S AXIS.—M. Folie, having deduced a periodic formula for the secular variations in obliquity and in longitude, applies the designation secular nutation of the earth's axis to these variations. Defining the normal equator as a plane the inclination of which to the ecliptic of a certain epoch is equal to the mean obliquity of that epoch, and the intersection of which with this latter plane passes at each instant through the mean equinox of that instant, he concludes that, in virtue of the secular nutation of the earth's axis, the mean pole describes round the normal pole, considered as fixed, an ellipse the major axis of which, directed towards the pole of the fixed ecliptic (i.e. the mean ecliptic of the epoch) is sensibly constant during several centuries. The period of the secular nutation is about 30,000 years, differing little from that of the precession on account of the slow motion of the node of the ecliptic, which is only 8"·7 per annum. Assuming a uniform value of 50" for the secular diminution of the obliquity, M. Folie compares the results obtained from his formula with ancient observations of the obliquity, and is thus led to announce that the empirical expression  $\epsilon_1 = -0''\cdot476 + 0''\cdot000018t$  for the annual diminution (where  $t$  is the number of years from 1850) satisfies very closely the observations from -250 to +1487. This expression, however, gives a considerably greater variation

to the secular diminution of the obliquity than that which results from Leverrier's researches.

ASTROPHYSICAL OBSERVATORY OF POTSDAM.—The first part of the fourth volume of the publications of this Observatory, which was published in the latter part of last year, contains three papers. The first of these is by Prof. Vogel, and contains the observations which he made with the great Vienna refractor in 1883 for the purpose of testing the performance of the great object-glass. Prof. Vogel's final verdict is altogether favourable: "The Vienna objective," he says, "leaves nothing to be desired as regards the precision of the images;" and he speaks of using with advantage a power even of 1500 upon planetary markings, a statement which is illustrated by a sketch of part of Saturn's ring, as seen with that magnifying power. His principal observations were, however, spectroscopic. Prof. Vogel utilising the great light-gathering power of the Vienna equatorial for a detailed examination of the remarkable spectra shown by several faint stars, classified by him under types II.  $\delta$  and III.  $\delta$ ; the former including spectra showing both dark and bright lines, and the latter, spectra crossed by dark bands, for the most part sharp towards the red and shaded towards the violet. The bright lines in the former class, with the exception of the green line of hydrogen, have not been identified with those of any element. The principal bands of the latter class Prof. Vogel refers, as Dr. Dunér does, to the absorption exercised by hydrocarbons in the atmosphere of the star. The paper also contains a number of observations of nebulae, principally planetary, and is illustrated by four lithographic plates.

The second paper contains meteorological observations made in the years 1881 to 1883, and the third is a very careful investigation by Dr. G. Müller of the influence of temperature on the refraction of light through prisms, of various kinds of glass, of Iceland-spar and rock-crystal.

COMETS FABRY AND BARNARD.—The brightness of these two comets continues to increase, Fabry's comet in particular promising ere long to be visible to the naked eye; and it seems probable that at the end of April and the beginning of May we may see the unusual spectacle of two bright comets near each other, and very nearly in the zenith.

The following ephemerides are given for Berlin midnight, that for Fabry's comet being by Dr. H. Oppenheim, and that for Barnard's by Dr. A. Krueger:—

<i>Fabry's Comet</i>											
1886	R.A.			Decl.	Log. $r$	Log. $\Delta$	Bright- ness				
	h.	m.	s.								
Feb. 19	23	21	32	27° 13' N.	0·0370	0·2058	4·1				
23	23	21	0	28 10·6	0·0121	0·1958	4·8				
27	23	20	27	29 11·0	9·9860	0·1836	5·7				
Mar. 3	23	19	49	30 14·8 N.	9·9591	0·1639	6·9				
<i>Barnard's Comet</i>											
Feb. 18	2	1	42	18 20·1 N.	0·2017	0·2412	2·9				
22	1	59	29	19 20·7	0·1836	0·2426	3·1				
26	1	57	39	20 23·4	0·1646	0·2432	3·4				
Mar. 2	1	56	8	21 28·4 N.	0·1443	0·2429	3·7				

STELLAR PHOTOGRAPHY.—The new nebula around Maia, discovered by means of the photographs taken at the Paris Observatory, has since been seen with the great Pulkova refractor.

M. Cruls, Director of the Rio de Janeiro Observatory, has been commissioned by the Emperor of Brazil to have a photographic apparatus constructed similar to that devised by the Brothers Henry at Paris, in order to co-operate with them in the proposed photographic survey of the sky.

HARVARD COLLEGE OBSERVATORY.—Prof. E. C. Pickering has issued his Report for the year 1885. As in former years, chief interest attaches to the photometric researches carried out at the Observatory. With the 15-inch equatorial the photometric observations of the eclipses of Jupiter's satellites have been continued. In all, 319 eclipses have now been observed, 35 since the end of October 1884. The reduction of the photometric observations of the zone stars between the declinations +0° 50' and +1° 0' has been carried on, and the observations of DM. stars between +49° 50' and +50° 0', as well as those between +54° 50' and +55° 0', have been completed. These observations have been made with the wedge photometer attached to the large equatorial. The resulting magnitudes have been computed by means of the stars occurring in the zones which are also under observation with the meridian photometer.